SEAL

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Abstract

In SEAL at the Wildwood school several new techniques were employed to further the development of this project. The main focus during the Spring of 2013 has been to test for a correlation between the relative concentration of the metals in the plates and the resulting output voltage of the plate. In order to run this test a linear algebraic method was used on a subset of the previous SEAL data, which was compiled into a matrix, and the output voltages, which was compiled into a vector. The hypothesis formed stated that if there is a definite correlation between the relative concentration of the metals, then when there is a concentration matrix within metal space it yields predictable output voltages depending on the metal utilized. Furthermore an equation was formed that if equal, would provide evidence of this correlation. This method is robust enough so that if no correlation is found, other possible relationships could be explored. Along with using matrices to test the new hypothesis one of the other advancements in this branch of SEAL was a unique testing rig...

Introduction

Currently, Hydrogen fuel cells are one of the most promising means of clean energy production. Unfortunately, current means of producing hydrogen through solar energy is not cost-effective or efficient. While there are materials, such as Platinum, which can be used to efficiently photocatalyze the splitting of water, none are cost-effective on any meaningful scale. Therefore, the goal of Solar Energy Activity Lab(SEAL), is to find less expensive metal compounds which can efficiently photocatalyze the splitting of water. Over the course of this project we have tested different metal alloys on conductive plates soaked in an electrolytic solution. Plates' photocatalytic response to sunlight is simulated using LED and correlated to an output voltage.

Plate Spotting Algorithm

When making testing plates we used the same algorithm to maximize redundancy (pictured left). This algorithm assigns the 3 elements used in each plate the variable of I, J, or K and each spot has a different relative concentration of these values. The relative concentrations are repeated 4 or 2 times depending on whether all 3 variables are unique, or just 2. For all plates an extra layer of iron was added around two sides as a control.

	A	B	C	D	E	F	G	H	I
1	i:j:k	j=0	j=1	j=2	j=3	j=4	j=5	j=6	j=7
2	i=0	(0:0:7) 1,1	(0:1:6) 1,2	(0:2:5) 1,3	(0:3:4) 1,4	(0:1:6) 1,2	(0:2:5) 1,3	(0:3:4) 1,4	Fe
3	i=1	(1:0:6) 2,1	(1:1:5) 2,2	(1:2:4) 2,3	(1:3:3) 2,4	(1:1:5) 2,2	(1:2:4) 2,3	(1:3:3) 2,4	Fe
4	i=2	(2:0:5) 3,1	(2:1:4) 3,2	(2:2:3) 3,3	(2:3:2) 3,4	(2:1:4) 3,2	(2:2:3) 3,3	(2:3:2) 3,4	Fe
5	i=3	(3:0:4) 4,1	(3:1:3) 4,2	(3:2:2) 4,3	(3:3:1) 4,4	(3:1:3) 4,2	(3:2:2) 4,3	(3:3:1) 4,4	Fe
6	i=4	(1:0:6) 2,1	(1:1:5) 2,2	(1:2:4) 2,3	(1:3:3) 2,4	(1:1:5) 2,2	(1:2:4) 2,3	(1:3:3) 2,4	Fe
7	i=5	(2:0:5) 3,1	(2:1:4) 3,2	(2:2:3) 3,3	(2:3:2) 3,4	(2:1:4) 3,2	(2:2:3) 3,3	(2:3:2) 3,4	Fe
8	i=6	(3:0:4) 4,1	(3:1:3) 4,2	(3:2:2) 4,3	(3:3:1) 4,4	(3:1:3) 4,2	(3:2:2) 4,3	(3:3:1) 4,4	Fe
9	i=7	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe
10									
11		k=7-(i+j)	i=1,2,3	j=1,2,3					

Linear Algebra

Is relative concentration for a metal sample correlated with output voltage? To test this hypothesis the relative concentrations were converted to a matrix, C, and the output voltage towards a vector, v.

$$C = \begin{vmatrix} C_{11} & C_{12} & C_{13} & . & . \\ C_{21} & C_{22} & . & & \\ C_{31} & . & & . & \\ \dots & . & & & . \\ C_{n1} & . & & & \end{vmatrix} \quad \text{and } v = \begin{vmatrix} V_1 \\ V_2 \\ \dots \\ V_n \end{vmatrix}$$

If this is true, then the voltage vector will be very similar to the sum of the products of the eigenvalues and eigenvectors of the concentration matrix. To test this, we find the eigenvalues (lambda_i) and eigenvectors (x_i) of the concentration matrix, and then find the sum of the products of the eigenvalues and eigenvectors as a comparison to the voltage vector.

Conclusion

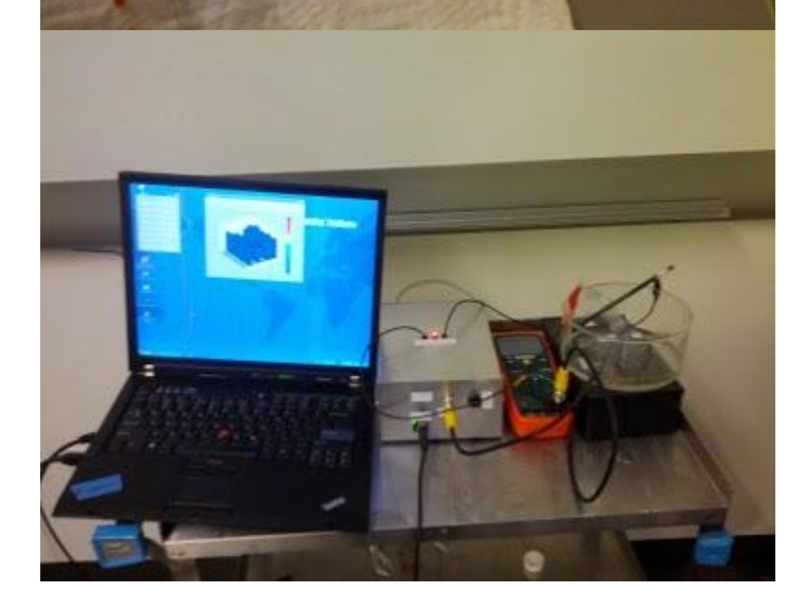
The average, and standard deviation on, voltage, for all of the participating schools, was determined, and the ratio was calculated for both all Iron plates and plates made with an equal mixture of Iron, Cobalt, and Nickel.

$\mu = \textit{average voltage}$

$\sigma = \textit{standard deviation on voltage}$

Fe:Co:Ni (1:1:1)	$\frac{\mu}{\sigma} \approx 0.84$
Fe	$\frac{\mu}{\sigma} \approx 2.52$

The high degree of variability in data across all participating schools implies that the linear algebra method will not yield reliable results if applied across all the data at once.



References and Acknowledgments

Resources

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